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STATISTICAL ANALYSIS ON SELF-AFFINE FRACTAL INTERFACE OF POLYCRYSTALLINE NH_4Cl FILM

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ABSTRACT The frontline of growing NH_4Cl polycrystalline film is studied in (1+1) dimension. The roughness exponent $\alpha \sim 0.7$ is obtained. In this study, the appropriate coordinate system that represents anisotropy of self-affine geometry are carefully selected as the linear correlation coefficient of the interface coordinates is to be vanished. This could be the explanation for the difference of the value of this study from the previous work[1].

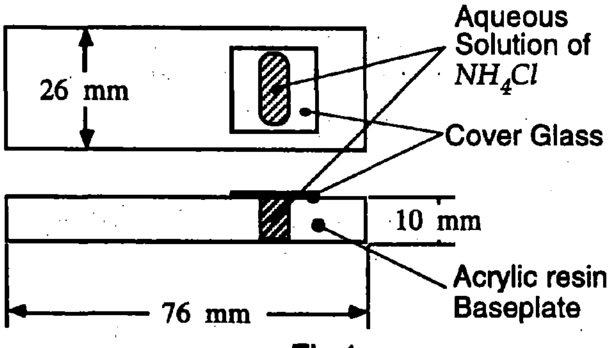

Fig.1

INTRODUCTION A variety of morphologies can be observed in crystal growth, such as polyhedron, dendrite, DLA, etc. Among them, there exists another phase with roughly developed interface. In recent study[1], it is shown that the interface of polycrystalline film of an NH_4Cl, which consists of grains and network of grain boundaries, has self-affine fractal characteristics in smaller scales of $L < 1mm$. Our intention is to understand whether the same scaling relation is still satisfied in lager length scales. The scaling law can be expressed as, $<\sigma>(L,t) \propto L^{\alpha}\Psi\left(\frac{t}{\tau}\right)$, where <σ> is mean standard deviation, L and t are spatial length scale and time respectively. The exponent α is called as "Roughness exponent." In Addition, the function $\Psi(x)$ has to have the property, $\Psi(x) \propto x^{\beta}, (for\ x << 1)$ and $\Psi(x) \sim const. (for\ x >> 1)$. The exponent β is called as "Growth exponent."

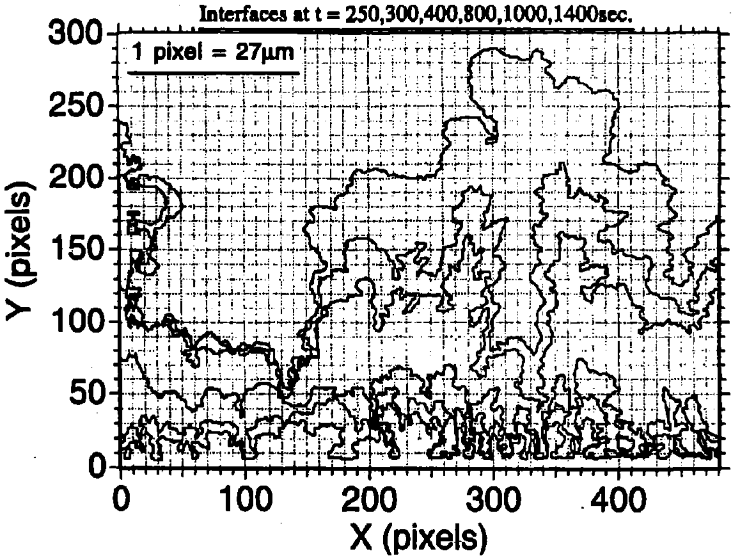

Fig. 2

EXPERIMENT The essential part of the experimental apparatus is shown in Fig.1. The baseplate of acrylic resin, that is also reservoir for the aqueous solution of an NH_4Cl, is mounted in copper holder whose temperature is controlled. The temperature of the baseplate is held at a certain value that is high above the saturation temperature of the solution so as not to start solidification in the reservoir. - the temperature of the baseplate was 45 *degC* and the concentration of the

solution was 0.447*g/ml*.
The temperature and relative humidity, monitored at 12cm above of the baseplate, were 33.5 *deg*C and 31.5% respectively. The crystallization process is triggered by placing the cover glass on the solution reservoir. Instantly,the solution spreads out to the fringe of the cover glass and after a while the nucleation takes place at the fringe, concentrated by the evaporation of the solvent. After the nucleation occurs, it makes polycrystalline film that has roughly developed interface. The successive profiles of the growing interfaces are recorded digitally with video camera and A/D-converter with a spatial resolution of 640x480 pixels, that gives about two decades of spacial range of measurement at maximum.

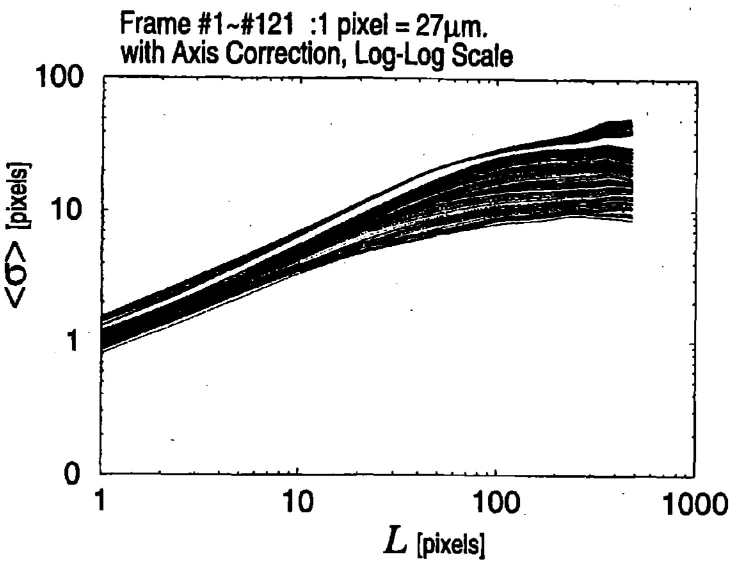

Fig. 3

RESULTS AND DISCUSSION An example of interfaces after correction of geometrical distortion is shown in Fig. 2. These six interfaces belong to a series of pictures that consist of several hundreds of images, sampled per 10 seconds.The <σ> of the interface is calculated in the coordinate system in which the covariance vanishes. After this transformation, overhangs are eliminated to make the interfaces single-valued function. The scaling property <σ> vs. L varying time is shown in Fig. 3. The dominant origin of biases of these curves is perhaps the overhang elimination since the vertical leap introduced by the process is small structure (or, 1 pixel width).

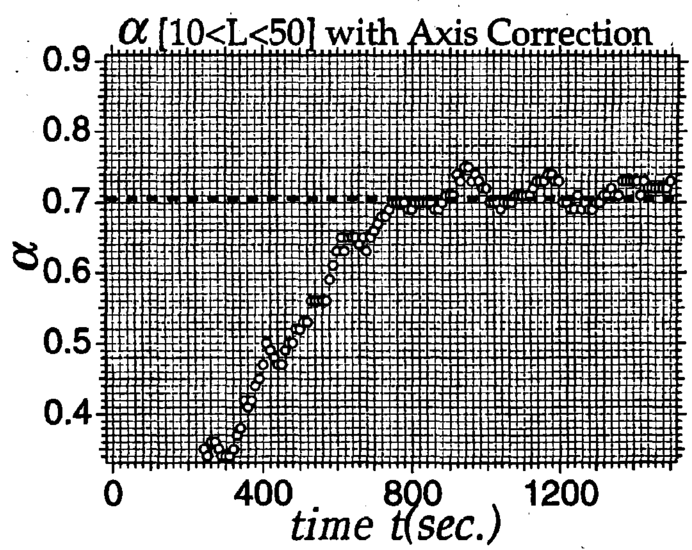

Fig. 4

The value of α is obtained through gradients of these curves (Fig. 4), that give ~0.7. In addition τ is estimated as 700~800sec. Now we are trying to get the growth exponent β with this system, but not yet accomplished.

REFERENCE

1. H. Honjo and S.Ohta, Phys. Rev. **E49** R1808 (1994).